

C L A I M S

1. A method of inhibiting sulfide production by sulfate-reducing bacteria (SRB), said method comprising the steps of:
 - (a) contacting the SRB with a first concentration of a biocide component, wherein said first concentration is less than about 90% of the minimum inhibitory concentration (MIC) of the biocide component; and
 - (b) contacting the SRB with a second concentration of a metabolic inhibitor component, wherein said second concentration is less than about 90% of the MIC of the metabolic inhibitor component.
- 5 2. The method of claim 1, wherein at least one of said first and second concentrations is less than about 50% of its MIC.
- 10 3. The method of claim 1, wherein said first and second concentrations are both less than about 75% of their respective MICs.
- 15 4. The method of claim 1, wherein at least one of said first and second concentrations is less than about 25% of its MIC.
5. The method of claim 4, wherein said first and second concentrations are both less than about 50% of their respective MICs.
6. The method of claim 1, wherein at least one of said first and second concentrations is less than 20% of its MIC.
- 20 7. The method of claim 6, wherein said first and second concentrations are both less than about 35% of their respective MICs.
8. The method of claim 1, wherein said second concentration is in the range of from about 0.1 mM to about 5 mM.
- 25 9. The method of claim 8, wherein said first concentration is less than about 50% of the MIC of the biocide component.
10. The method of claim 1, wherein said biocide component is a combination of more than one individual biocide and/or said metabolic inhibitor component is a combination of more than one individual metabolic inhibitor.
11. The method of claim 1, wherein said biocide component comprises substantially no tetrakis hydroxymethyl phosphonium sulfate (THPS).
- 30 12. The method of claim 1, wherein said biocide component is selected from the group consisting of aldehydes, amine-type compounds, halogenated compounds,

sulfur compounds, quaternary phosphonium salts, and combinations of one or more thereof.

13. The method of claim 1, wherein said metabolic inhibitor component is selected from the group consisting of nitrite, molybdate, tungstate, selenate, 5 anthraquinone and combinations of one or more thereof.

14. The method of claim 1, wherein said biocide component is selected from the group consisting of formaldehyde, glutaraldehyde, acrolein, quaternary amine compounds, cocodiamine, bronopol, 2-2-dibromo-3-nitrilo-propionamide (DBNPA), isothiazolone, carbamates, metronidazole, and combinations of one or more thereof.

10 15. The method of claim 1, wherein said biocide component comprises glutaraldehyde and said metabolic inhibitor component comprises nitrite.

16. The method of claim 1, wherein said biocide component consists essentially of glutaraldehyde and said metabolic inhibitor component consists essentially of nitrite.

15 17. The method of claim 1, wherein step (a) includes directly killing a first portion of the SRB and step (b) includes inhibiting sulfate-reducing growth of a second portion of the SRB without directly killing the second portion of the SRB.

18. The method of claim 1, wherein steps (a) and (b) are performed substantially continuously and said first and second concentrations are average 20 concentrations over time.

19. The method of claim 1, wherein steps (a) and (b) are performed intermittently and said first and second concentrations are average concentrations over time.

20. The method of claim 1, wherein steps (a) and (b) are performed 25 simultaneously.

21. The method of claim 1, further comprising the step of:

(c) prior to steps (a) and (b), combining the biocide component or a precursor of the biocide component and the metabolic inhibitor component or a precursor of the metabolic inhibitor component in a treated medium.

30 22. The method of claim 21, wherein steps (a) and (b) include contacting the SRB with the treated medium.

23. The method of claim 21, wherein said treated medium is an

aqueous-based medium.

24. The method of claim 21, wherein said treated medium comprises at least about 50% water by weight.

25. The method of claim 21, wherein said treated medium comprises in the range of from about 0.1 mM to about 5 mM nitrite.

26. The method of claim 25, wherein said treated medium comprises in the range of from about 0.1 mM to about 5 mM glutaraldehyde.

27. A method comprising contacting sulfate reducing bacteria (SRB) with a treated medium comprising an aldehyde and a metabolic inhibitor selected from the group consisting of nitrite, molybdate, and combinations thereof, wherein said aldehyde and said metabolic inhibitor are present in the treated medium in an aldehyde to metabolic inhibitor molar ratio in the range of from about 50:1 to about 1:50.

28. The method of claim 27, wherein said metabolic inhibitor comprises nitrite.

29. The method of claim 28, wherein said biocide comprises glutaraldehyde.

30. The method of claim 27, wherein said aldehyde to metabolic inhibitor molar ratio is in the range of from about 20:1 to about 1:20.

31. The method of claim 27, wherein said aldehyde to metabolic inhibitor molar ratio is in the range of from 10:1 to 1:10, wherein said metabolic inhibitor consists essentially of nitrite, and wherein said biocide consists essentially of glutaraldehyde.

32. The method of claim 27, wherein said aldehyde and said metabolic inhibitor are each present in the treated medium in a concentration in the range of from about 0.1 mM to about 5 mM.

25. 33. The method of claim 32, wherein said contacting is performed substantially continuously and said concentrations of the aldehyde and metabolic inhibitor in the treated medium are average concentrations over time.

34. The method of claim 32, wherein said contacting is performed intermittently and said concentrations of the aldehyde and metabolic inhibitor in the treated medium are average concentrations over time.

30. 35. The method of claim 27, wherein said aldehyde and said metabolic inhibitor are each present in the treated medium in a concentration in the range of from

about 0.1 mM to about 2 mM.

36. The method of claim 27, wherein said aldehyde is present in the treated mixture in a first concentration that is less than about 90% of the minimum inhibitory concentration (MIC) of the aldehyde and said metabolic inhibitor is present in the treated mixture in a second concentration that is less than about 90% of the MIC of the metabolic inhibitor.

5 37. The method of claim 36, wherein at least one of said first and second concentrations is less than about 35% of its MIC.

10 38. The method of claim 37, wherein said aldehyde comprises glutaraldehyde and said metabolic inhibitor comprises nitrite.

15 39. The method of claim 27, wherein said aldehyde is present in the treated mixture in a first concentration that is less than about 50% of the minimum inhibitory concentration (MIC) of the aldehyde and said metabolic inhibitor is present in the treated mixture in a second concentration that is less than about 50% of the MIC of the metabolic inhibitor.

40. The method of claim 39, wherein at least one of said first and second concentrations is less than 25% of its MIC.

41. The method of claim 40, wherein said aldehyde consists essentially of glutaraldehyde and said metabolic inhibitor consists essentially of nitrite.

20 42. A composition for effectively inhibiting sulfide production by sulfate-reducing bacteria (SRB), said composition comprising:

25 (a) a biocide component capable of directly killing a first portion of the SRB, wherein said biocide component is present in the composition in a first concentration that is less than about 90% of the minimum inhibitory concentration (MIC) of the biocide component; and

30 (b) a metabolic inhibitor component capable of inhibiting the sulfate-reducing growth of a second portion of the SRB without directly killing the second portion of the SRB, wherein said metabolic inhibitor component is present in the composition in a second concentration that is less than about 90% of the MIC of the metabolic inhibitor component.

43. The composition of claim 42, wherein at least one of said first and second concentrations is less than about 35% of its MIC.

44. The composition of claim 43, wherein said first and second concentrations are both less than about 50% of their respective MICs.

45. The composition of claim 42, wherein said at least one of first and second concentrations is less than 25% of its MIC.

5 46. The composition of claim 45, wherein said first and second concentrations are both less than about 35% of their respective MICs.

47. The composition of claim 42, wherein said biocide component is a combination of more than one individual biocide and/or said metabolic inhibitor component is a combination of more than one individual metabolic inhibitor.

10 48. The composition of claim 42, wherein said biocide component comprises substantially no tetrakis hydroxymethyl phosphonium sulfate (THPS).

49. The composition of claim 42, wherein said biocide component is selected from the group consisting of aldehydes, amine-type compounds, halogenated compounds, sulfur compounds, quaternary phosphonium salts, and combinations of one or more thereof.

15 50. The composition of claim 42, wherein said metabolic inhibitor component is selected from the group consisting of nitrite, molybdate, tungstate, selenate, anthraquinone, and combinations of one or more thereof.

51. The composition of claim 42, wherein said biocide component is selected from the group consisting of formaldehyde, glutaraldehyde, acrolein, quaternary amine compounds, cocodiamine, bronopol, 2-2-dibromo-3-nitrilo-propionamide (DBNPA), isothiazolone, carbamates, metronidazole, and combinations of one or more thereof.

20 52. The composition of claim 42, wherein said biocide component comprises glutaraldehyde and said metabolic inhibitor component comprises nitrite.

25 53. The composition of claim 42, wherein said biocide component consists essentially of glutaraldehyde and said metabolic inhibitor component consists essentially of nitrite.

54. The composition of claim 42, further comprising at least about 2% by weight water.

30 55. The composition of claim 42, further comprising at least 50% by weight water.

56. A composition comprising:

- 17 -

- (a) an aldehyde; and
- (b) a metabolic inhibitor selected from the group consisting of nitrite, molybdate, and combinations thereof,
 - wherein said aldehyde and said metabolic inhibitor are present in the composition in an aldehyde to metabolic inhibitor molar ratio in the range of from about 50:1 to about 1:50.

5. 57. The composition of claim 56, wherein said metabolic inhibitor comprises nitrite.

10. 58. The composition of claim 57, wherein said biocide comprises glutaraldehyde.

59. The composition of claim 56, wherein said aldehyde to metabolic inhibitor molar ratio is in the range of from about 20:1 to about 1:20.

15. 60. The composition of claim 56, wherein said aldehyde to metabolic inhibitor molar ratio is in the range of from 10:1 to 1:10, wherein said metabolic inhibitor consists essentially of nitrite, and wherein said biocide consists essentially of glutaraldehyde.

61. The composition of claim 56, wherein said aldehyde and said metabolic inhibitor are each present in the composition in a concentration in the range of from about 0.1 mM to about 5 mM.

20. 62. The composition of claim 56, wherein said aldehyde and said metabolic inhibitor are each present in the composition in a concentration in the range of from about 0.1 mM to about 2 mM.

63. The composition of claim 56, wherein said aldehyde comprises glutaraldehyde and said metabolic inhibitor comprises nitrite.

25. 64. The composition of claim 56, wherein said aldehyde consists essentially of glutaraldehyde and said metabolic inhibitor consists essentially of nitrite.